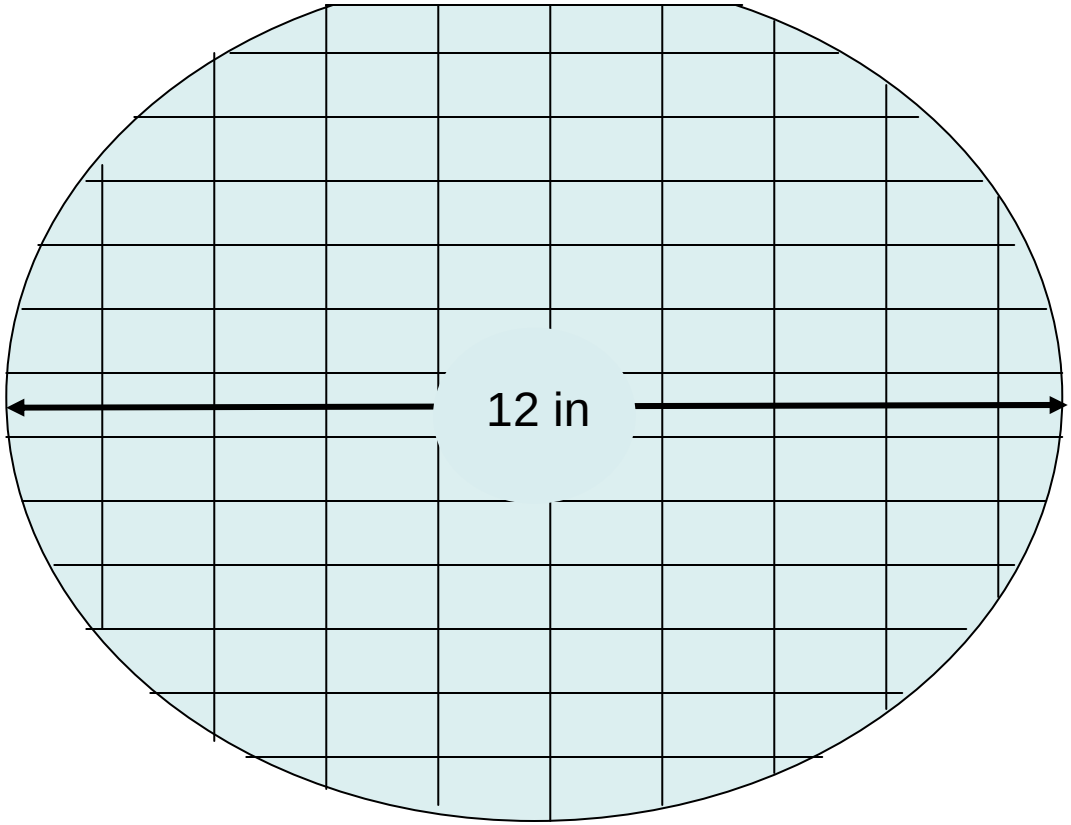
EE 434
Lecture 4

Basic Logic Circuits

Quiz 2

If the hard yield of a die on a 12 inch wafer in a 180nm process with a defect density of $1/cm^2$ is 90%, how many die are there on the wafer?



And the number is ....

1 8 7 5 3

6 9 4 2

Quiz 2

If the hard yield of a die on a 12 inch wafer in a 180nm process with a defect density of 1/cm^2 is 90%, how many die are there on the wafer?

Solution:

$$Y_H = e^{-Ad}$$

$$A = \frac{-\ln(Y_H)}{d} = \frac{-\ln(.9)}{1} = .105\text{cm}^2$$

$$N_{die} = \frac{A_{WAFER}}{A_{DIE}}$$

$$N_{die} = \frac{A_{WAFER}}{A_{DIE}} = \frac{\pi(6in)^2}{.105cm^2}\left(\frac{2.54cm}{in}\right)^2 = 6729$$

Review from Last Time

- Hard faults in die place a fundamental limit on practical die size and yield
- Soft faults are of considerable concern in many applications as well
- Arbitrary assignment of yield expectations to any part of a process is an invitation to financial disaster
- Semiconductor industry got its start about 50 years ago but only the growth in the past decade has made it one of major economic forces in the world economy

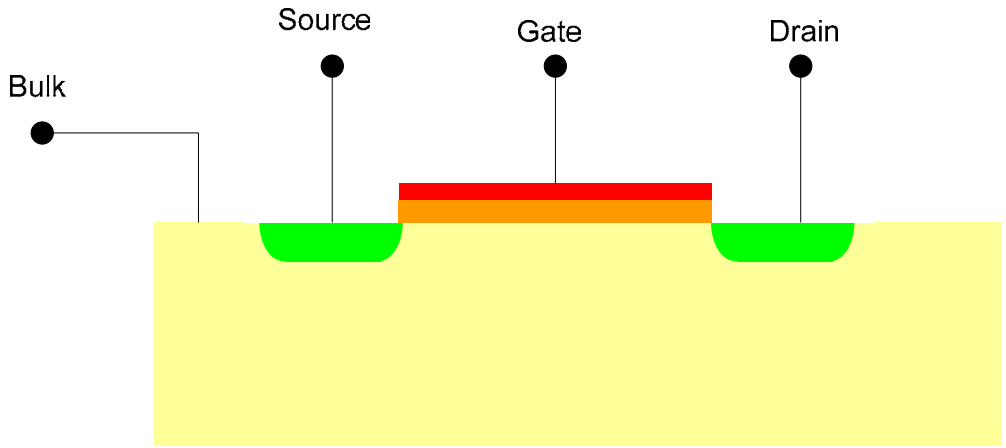
$$\sigma_A$$

Basic Logic Circuits

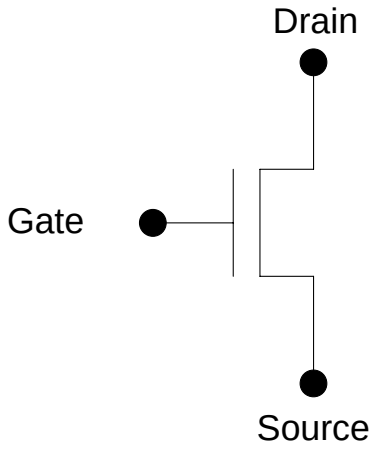
- Will present a brief description of logic circuits based upon simple models and qualitative description of processes
- Will discuss process technology needed to develop better models
- Will provide more in-depth discussion of logic circuits based upon better device models

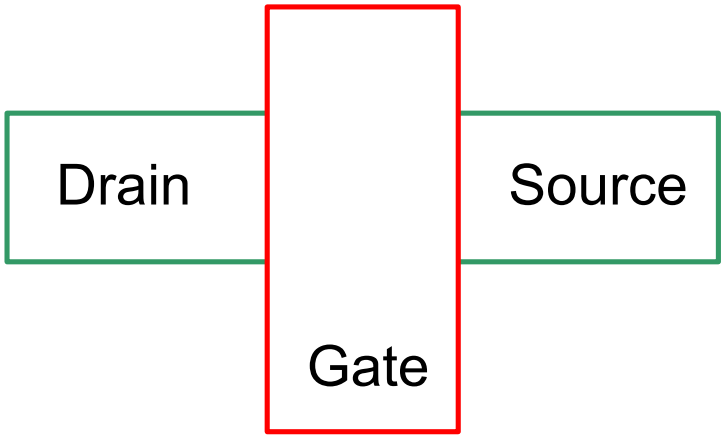
MOS Transistor

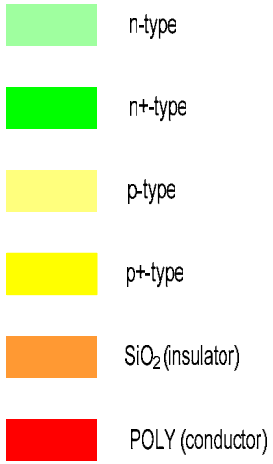
Qualitative Discussion of n-channel Operation



n-channel MOSFET

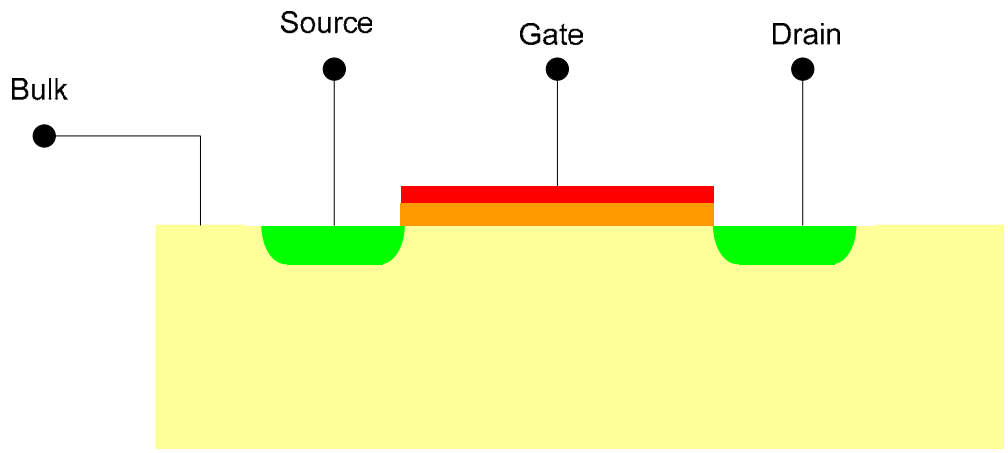




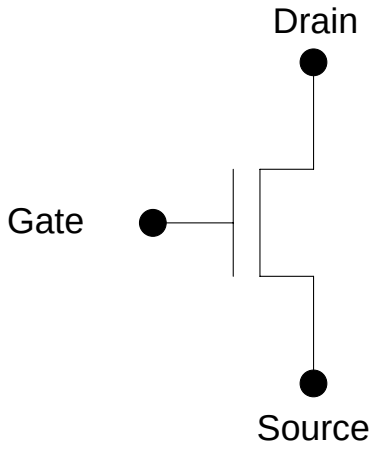


MOS Transistor

Qualitative Discussion of n-channel Operation



n-channel MOSFET



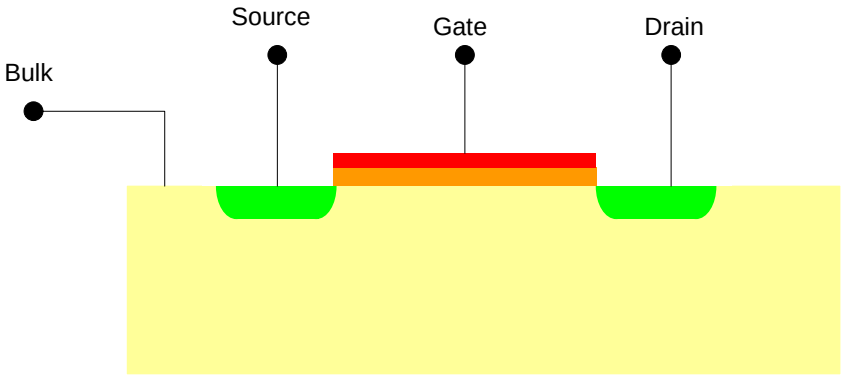
Behavioral Description of Basic Operation

If V_{GS} is large, short circuit exists between drain and source

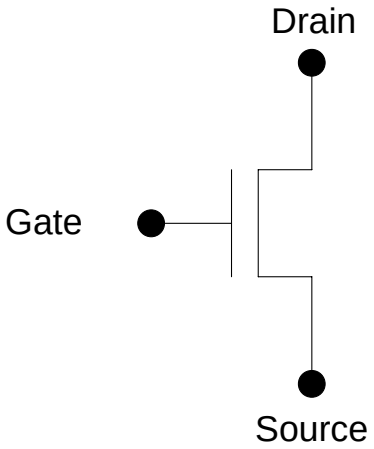
If V_{GS} is small, open circuit exists between drain and source

MOS Transistor

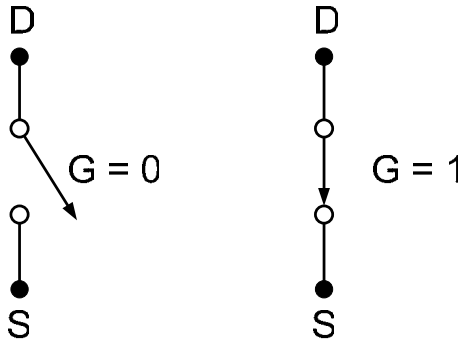
Qualitative Discussion of n-channel Operation



n-channel MOSFET

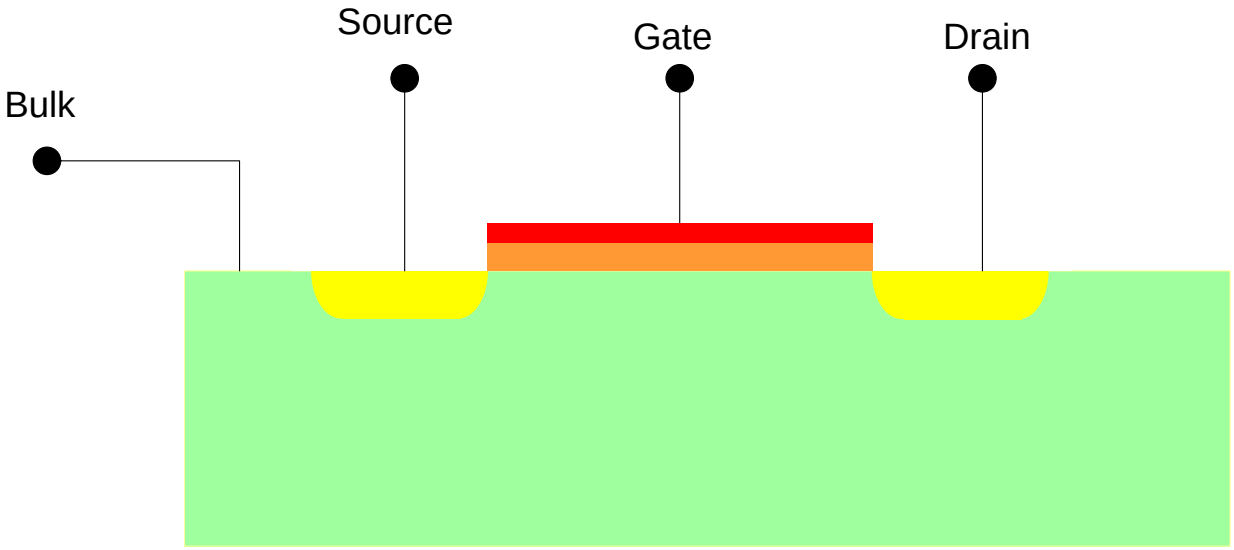


Equivalent Circuit for n-channel MOSFET

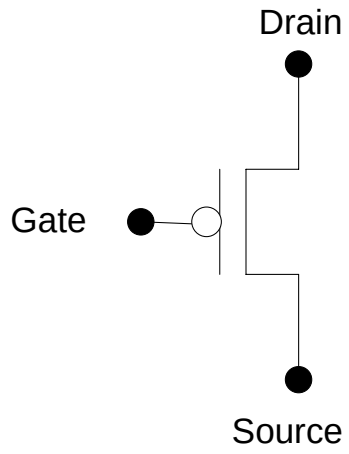


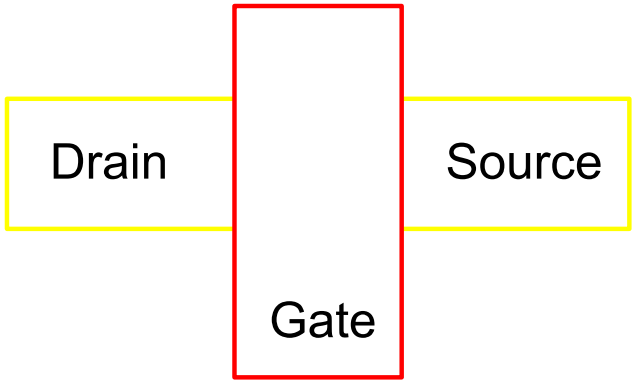
MOS Transistor

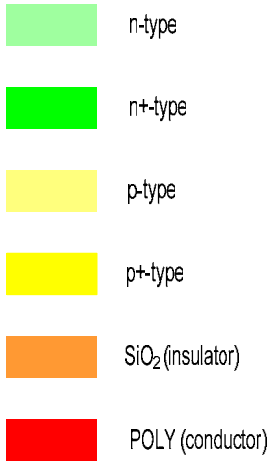
Qualitative Discussion of p-channel Operation



p-channel MOSFET

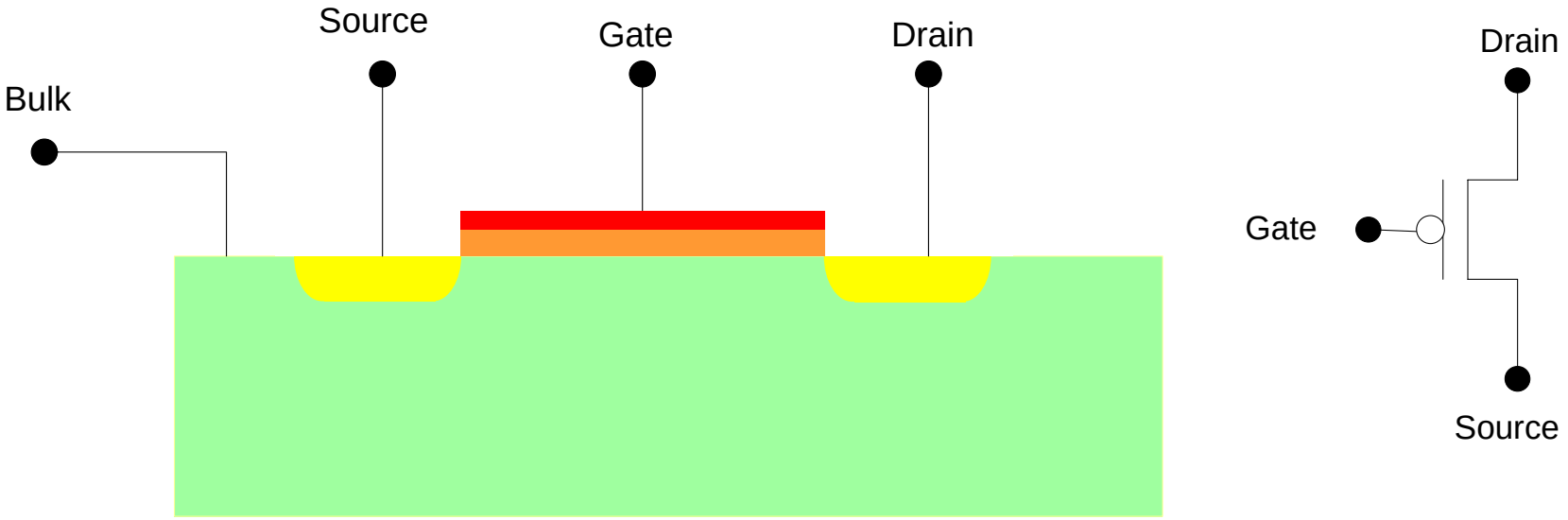






MOS Transistor

Qualitative Discussion of p-channel Operation



p-channel MOSFET

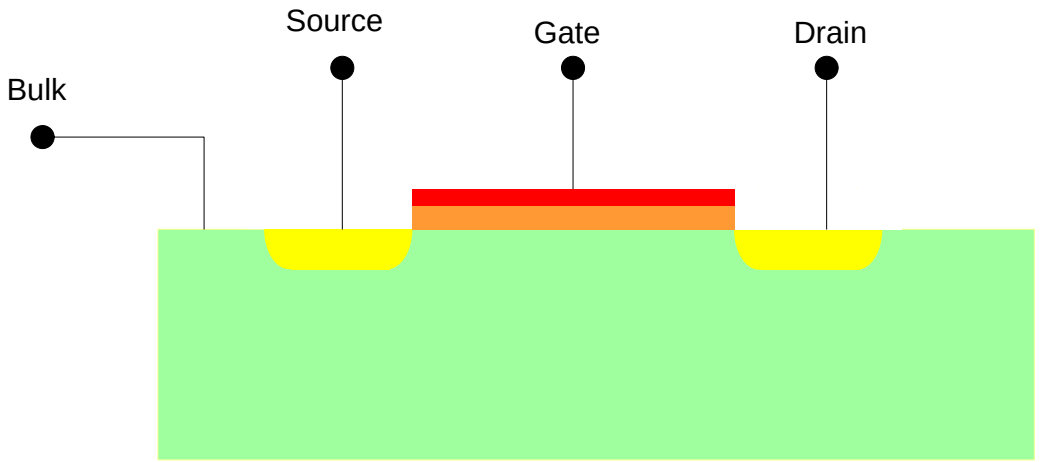
Behavioral Description of Basic Operation

If V_{GS} is small (negative), short circuit exists between drain and source

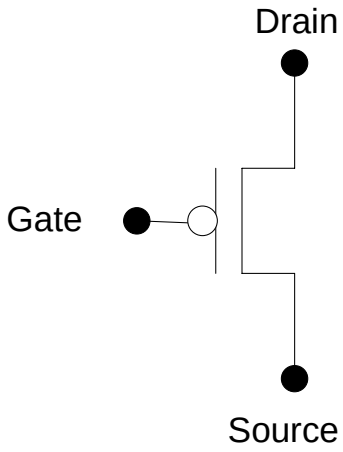
If V_{GS} is large (near 0), open circuit exists between drain and source

MOS Transistor

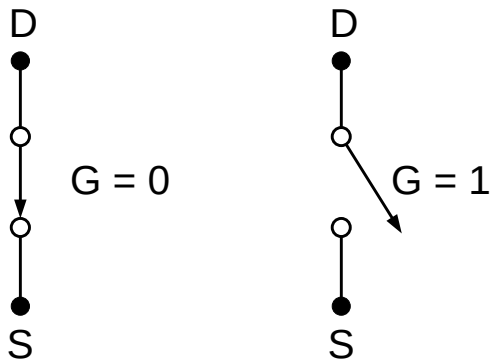
Qualitative Discussion of p-channel Operation



p-channel MOSFET

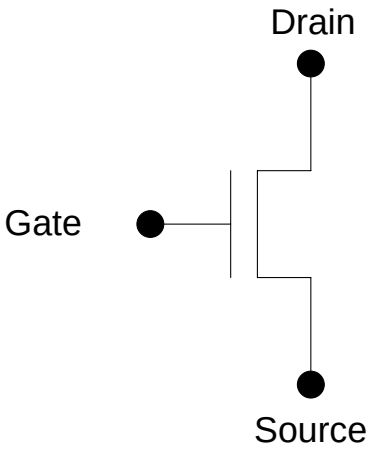


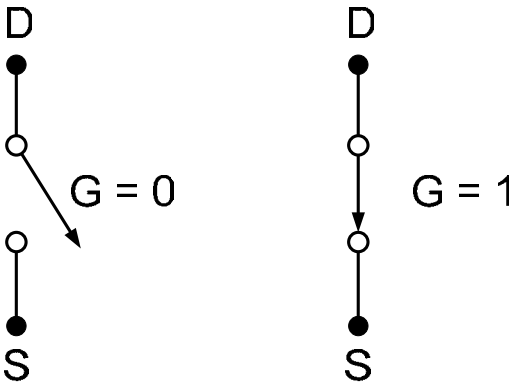
Equivalent Circuit for p-channel MOSFET

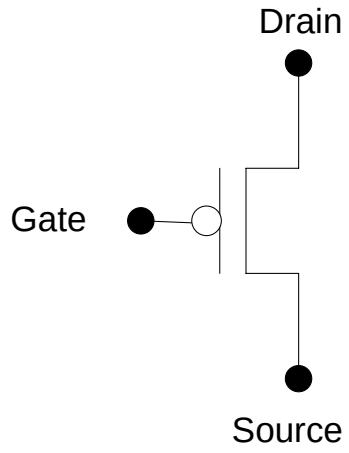


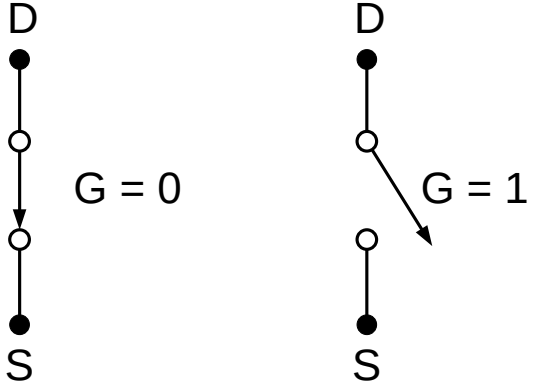
MOS Transistor

Comparison of Operation

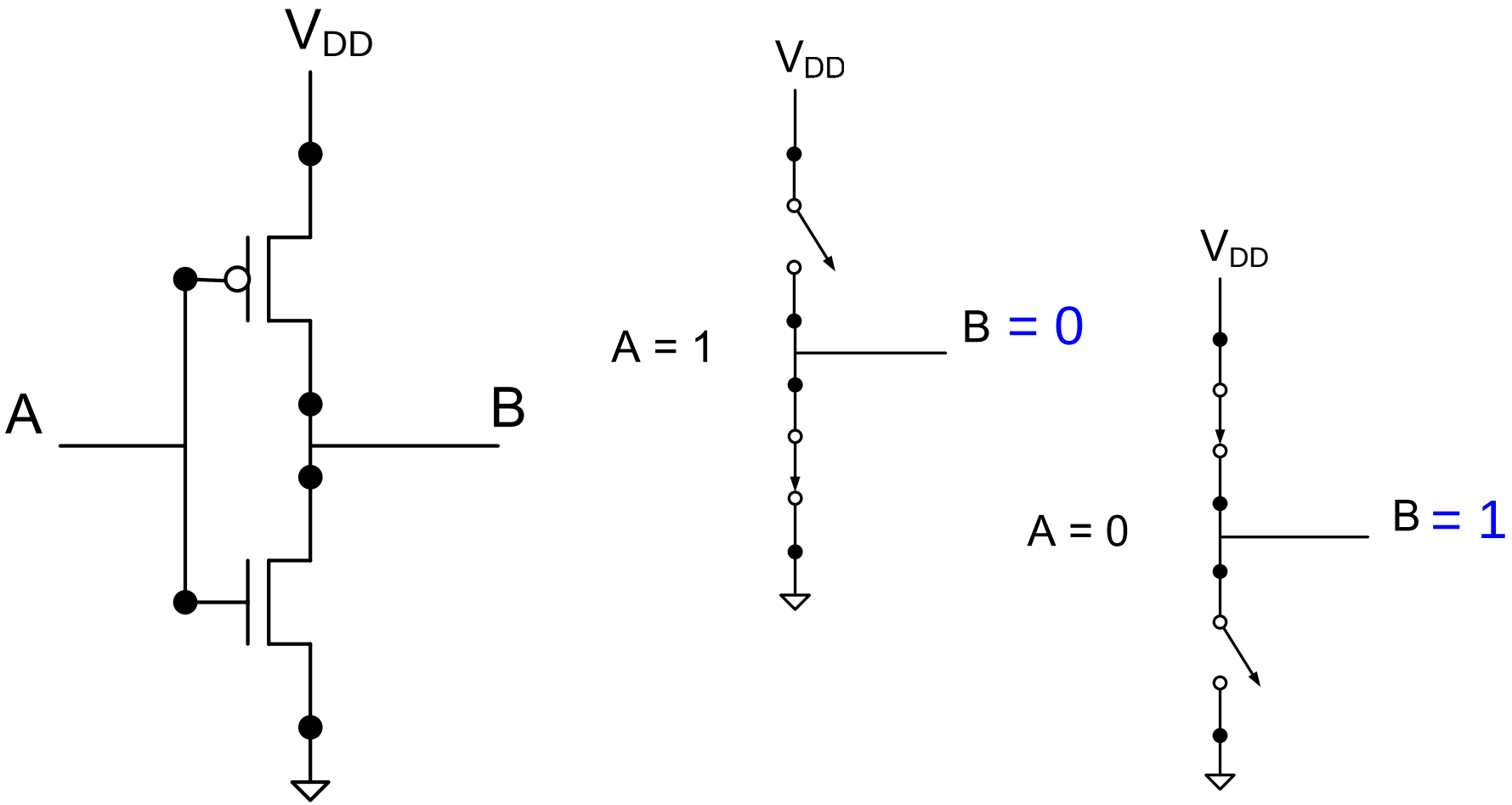






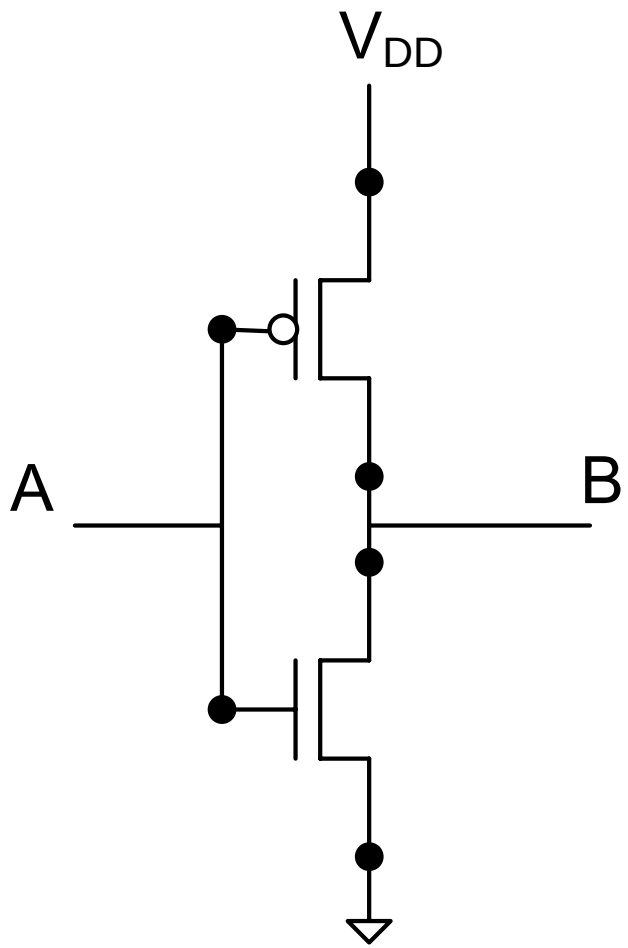


Logic Circuits



Circuit Behaves as a Boolean Inverter

Logic Circuits

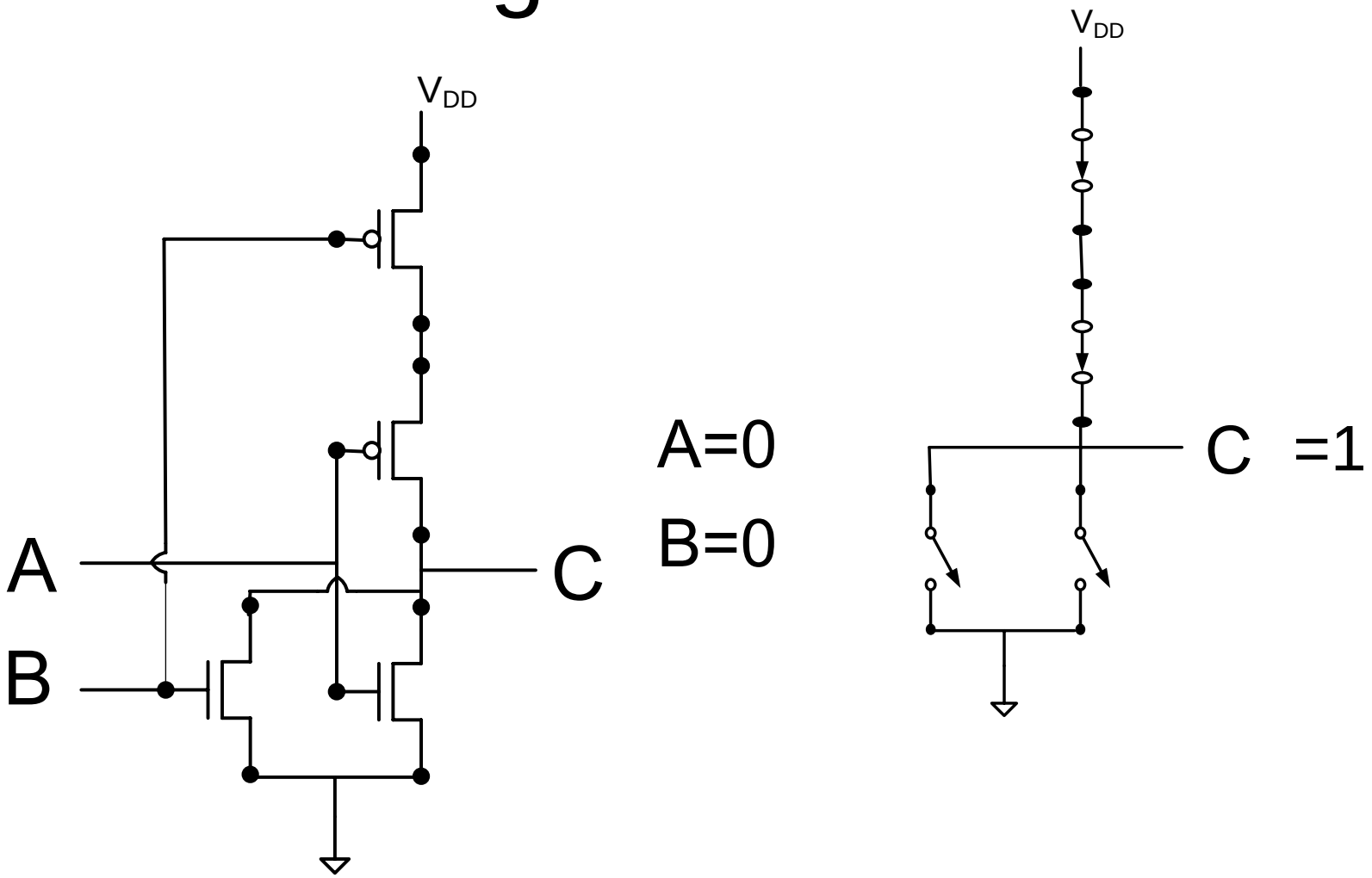


Inverter

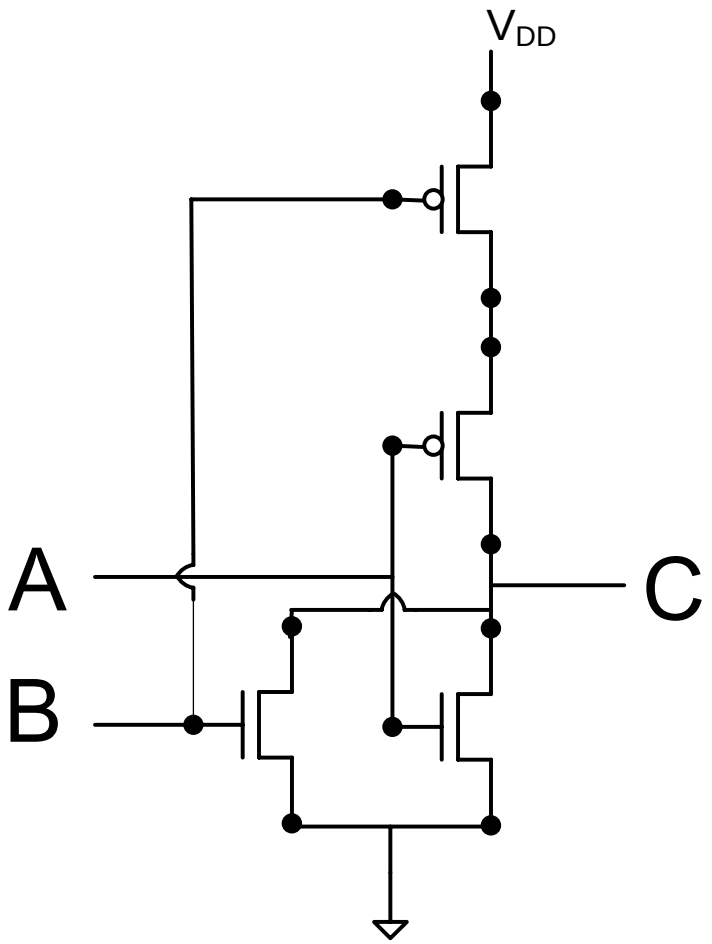
Truth Table

A	B
0	1
1	0

Logic Circuits

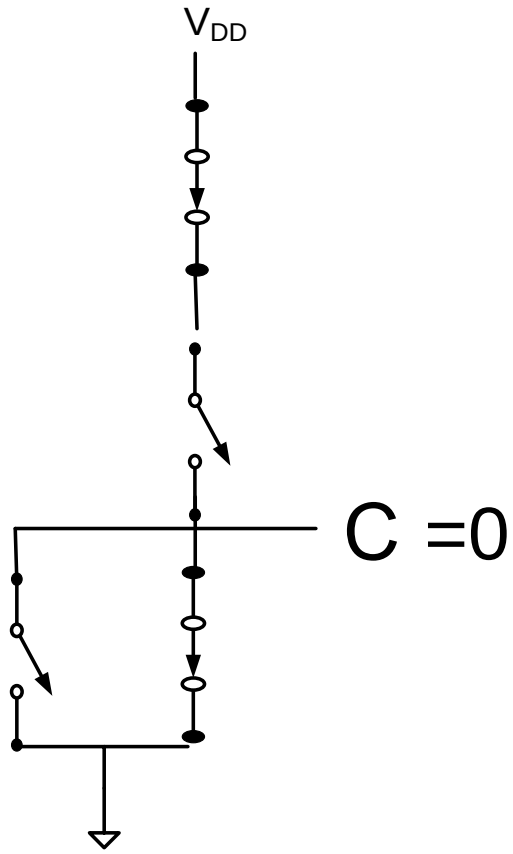


Logic Circuits

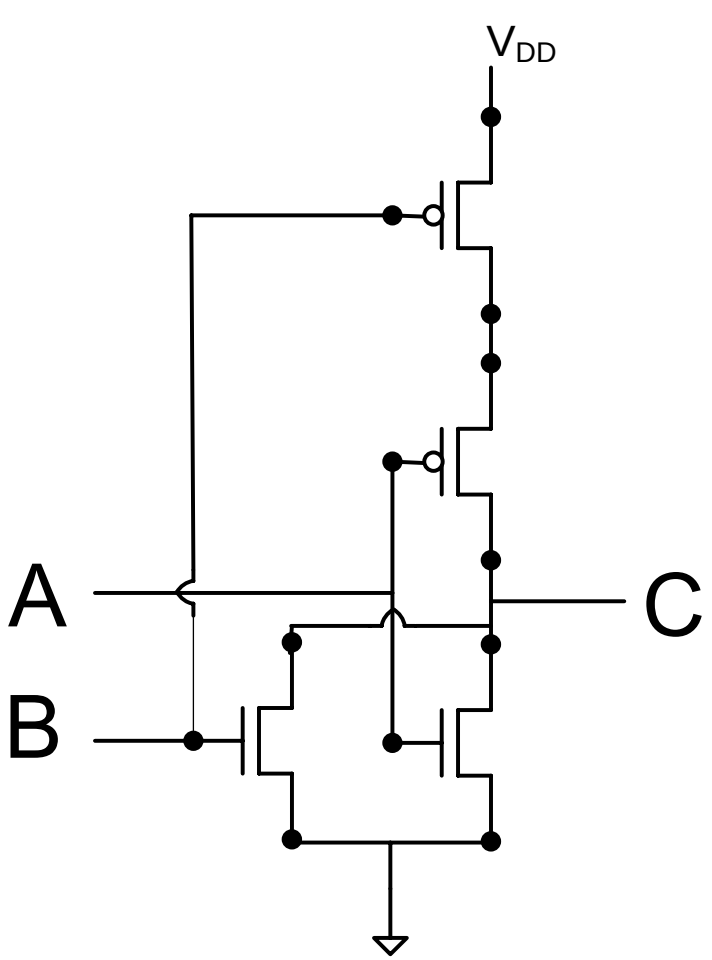


A=1

B=0

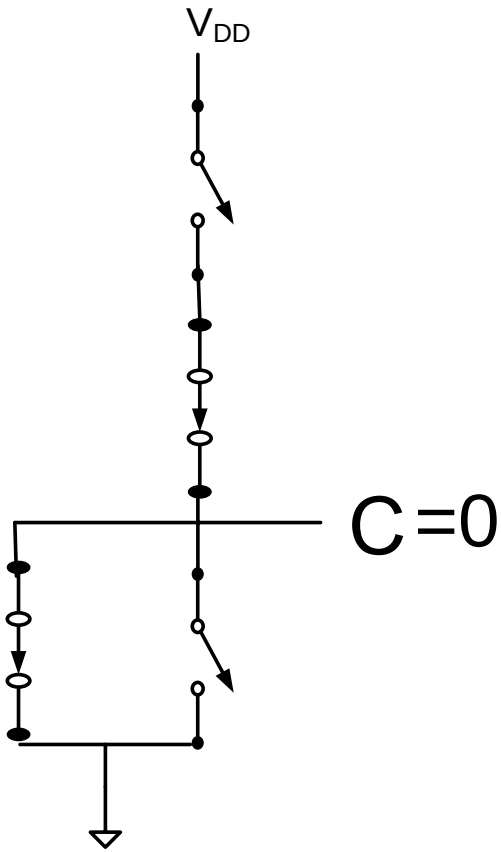


Logic Circuits

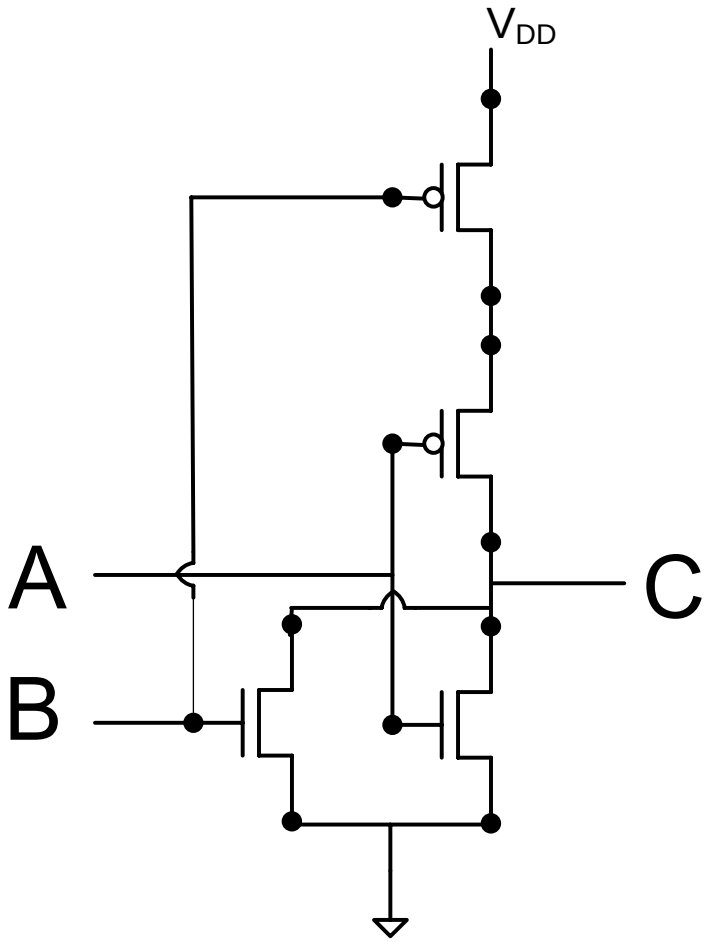


A=0

B=1

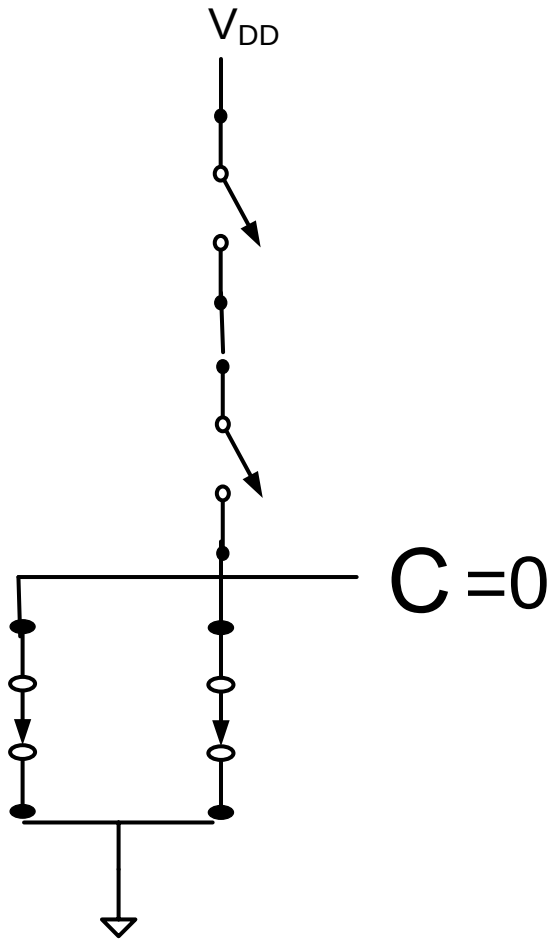


Logic Circuits

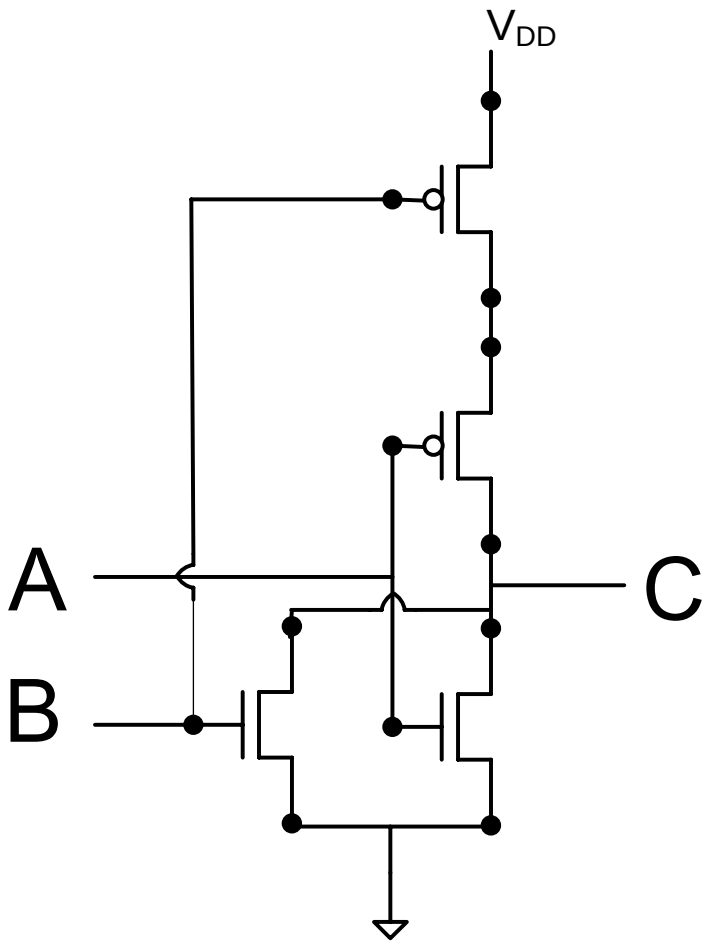


A=1

B=1



Logic Circuits

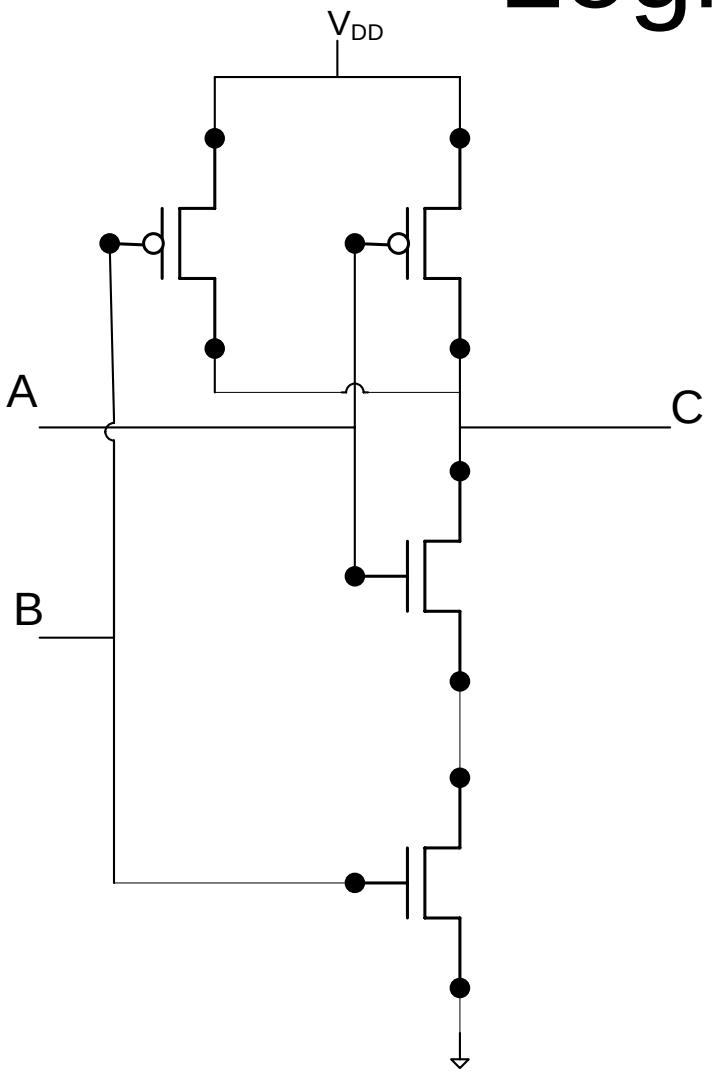


NOR Gate

Truth Table

A	B	C
0	0	1
0	1	0
1	0	0
1	1	0

Logic Circuits



NAND Gate

Truth Table

A	B	C
0	0	1
0	1	1
1	0	1
1	1	0